

742A Series

RESISTANCE STANDARDS

Instruction Manual

WARRANTY

John Fluke Mfg. Co., Inc. (Fluke) warrants this instrument to be free from defects in material and workmanship under normal use and service for a period of 1 year from date of shipment. Software is warranted to operate in accordance with its programmed instructions on appropriate Fluke instruments. It is not warranted to be error free. This warranty extends only to the original purchaser and shall not apply to fuses, computer media, batteries or any instrument which, in Fluke's sole opinion, has been subject to misuse, alteration, abuse or abnormal conditions of operation or handling.

Fluke's obligation under this warranty is limited to repair or replacement of an instrument which is returned to an authorized service center within the warranty period and is determined, upon examination by Fluke, to be defective. If Fluke determines that the defect or malfunction has been caused by misuse, alteration, abuse, or abnormal conditions of operation or handling, Fluke will repair the instrument and bill the purchaser for the reasonable cost of repair. If the instrument is not covered by this warranty, Fluke will, if requested by purchaser, submit an estimate of the repair costs before work is started.

To obtain repair service under this warranty purchaser must forward the instrument, (transportation prepaid) and a description of the malfunction to the nearest Fluke Service Center. The instrument shall be repaired at the Service Center or at the factory, at Fluke's option, and returned to purchaser, transportation prepaid. FLUKE ASSUMES NO RISK FOR IN-TRANSIT DAMAGE.

THE FOREGOING WARRANTY IS PURCHASER'S SOLE AND EXCLUSIVE REMEDY AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY, OR FITNESS FOR ANY PARTICULAR PURPOSE OR USE. FLUKE SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES OR LOSS WHETHER IN CONTRACT, TORT, OR OTHERWISE.

CLAIMS

Immediately upon arrival, purchaser shall check the packing container against the enclosed packing list and shall, within thirty (30) days of arrival, give Fluke notice of shortages or any nonconformity with the terms of the order. If purchaser fails to give notice, the delivery shall be deemed to conform with the terms of the order.

The purchaser assumes all risk of loss or damage to instruments upon delivery by Fluke to the carrier. If an instrument is damaged in transit, PURCHASER MUST FILE ALL CLAIMS FOR DAMAGE WITH THE CARRIER to obtain compensation. Upon request by purchaser, Fluke will submit an estimate of the cost to repair shipment damage.

Fluke will be happy to answer all questions to enhance the use of this instrument. Please address your requests or correspondence to: JOHN FLUKE MFG. CO., INC., P.O. BOX C9090, EVERETT, WA 98206,

INTRODUCTION

The 742A Series are small, light, rugged resistance standards. The standards require no temperature-controlled air or oil bath. The 742A Series are well suited for use as the following:

- Working standards
- Portable transfer standards
- Calibration support for the Fluke 5700A Calibrator

Stability and temperature coefficients of the 742A Series make them ideal for easy transport to and operation in any working environment within the range of 18 to 28°C. The standards come with six-month and one-year uncertainty specifications. Depending on the accuracy required, a 742A can be recertified at intervals based on either specification.

Each 742A comes with a Report of Calibration and a rear panel label showing the measured value. The rear panel also has a Fluke Primary Standards Lab calibration label, labels that show temperature coefficient alpha and beta centered on 23°C, and the standard's serial number.

NOTE

Refer to "How Temperature Correction Factors are Calculated," further on in this manual for definitions of alpha and beta.

SPECIFICATIONS

Table 1 lists specifications for the available 742A Series Resistance Standards.

Table 1. 742A Series Resistance Standard Specifications

| MODEL | NOMINAL RESISTANCE AT 23°C | TIME STABILITY | | CALIBRATION UNCERTAINTY | MAXIMUM DEVIATION FROM THE 23°C VALUE (18 TO 28°C) | MAXIMUM CURRENT (VOLTAGE) | POWER COEFFICIENT +1 PPM WHEN CURRENT EXCEEDS THE FOLLOWING |
|----------|----------------------------------|-------------------|----------|----------------------------|---|---------------------------------|--|
| | | 180 DAY | 1 YEAR | | | | |
| 742A-1 | 1Ω | ±5.0 ppm | ±8.0 ppm | ±1.0 ppm | 3.0 ppm | 500 mA (500 mV) | 200 mA |
| 742A-10k | 10 kΩ | ±2.5 ppm | ±4.0 ppm | ±1.0 ppm | 1.5 ppm | 3 mA (30V) | 0.6 mA |

GENERAL SPECIFICATIONS:

Accuracy: The initial resistance is trimmed to ± 2 ppm of nominal. The measured value is printed on the rear panel.

Operating Temperature Range: $23 \pm 5^\circ\text{C}$

Storage Temperature Range: 0 to 40°C

Report of Calibration: The report of calibration includes a table of resistance values in 0.5° increments from 18 to 28°C .

Size: 8.64 cm H x 10.54 cm W x 12.70 cm L (including binding posts)
(3.4 in H x 4.15 in W x 5.0 in L (including binding posts))
Binding posts; 2.54 cm (1.0 in)

Weight: 0.91 kg (2.0 lbs)

DESIGN AND CONSTRUCTION NOTES

The 742A Series are constructed of arrays of Fluke wirewound precision hermetically-sealed resistors. No adjustable resistors of any kind are used.

Each 742A is built with a temperature coefficient near zero at 23°C. To further reduce errors caused by temperature changes, the binding posts are constructed of low-thermal emf material.

FEATURES

Figure 1 shows a front panel view. Figure 2 shows a rear panel view. Table 2 describes binding post functions. Table 3 describes the rear panel labels.

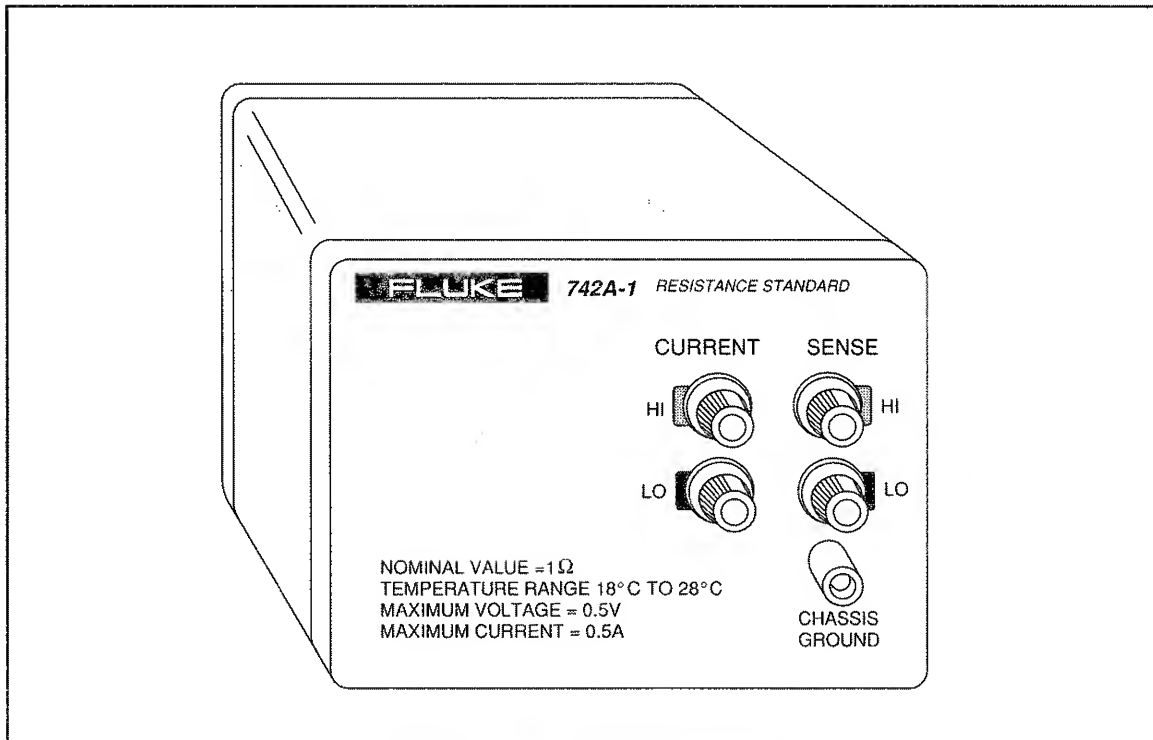


Figure 1. Typical Front Panel View

Table 2. Functions of the Binding Posts

| 742A BINDING POST | FUNCTION |
|-------------------|---|
| CURRENT HI | Input for the current source from an ohmmeter |
| CURRENT LO | Input for the current source from an ohmmeter |
| SENSE HI | Measurement point for a four-wire ohmmeter |
| SENSE LO | Measurement point for a four-wire ohmmeter |
| CHASSIS GROUND | Connected to the case for shielding |

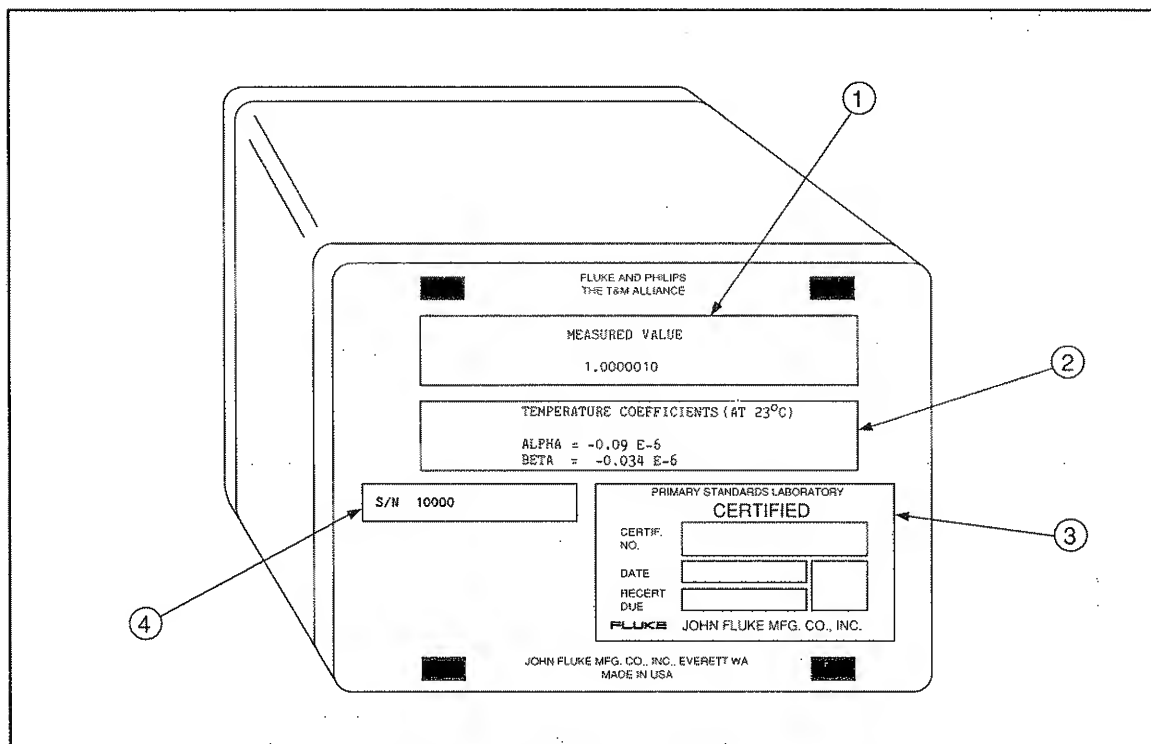


Figure 2. Typical Rear Panel View

Table 3. Contents of the Rear Panel Labels

| REF NO. | LABEL INFORMATION |
|---------|--|
| ① | Measured value label. Shows the measured value at $23 \pm 0.6^\circ$; the same as on the Report of Calibration. |
| ② | Temperature coefficient label. Shows alpha and beta centered on 23°C . Refer to "How Temperature Correction Factors are Calculated," further on in this manual for definitions of alpha and beta, and the formula to predict exact resistance at different temperatures. |
| ③ | Fluke Primary Standards Lab Calibration Label documents traceability to the U.S. National Bureau of Standards. |
| ④ | Serial number label. Shows the standard's serial number. This number and the full model number (i.e., 742A-1) positively identify a particular unit. |

OPERATING NOTES

This part of the manual explains operational and environmental considerations for the 742A Series. Follow these guidelines when operating or storing the resistance standard. Precautions for handling are under "Care and Maintenance."

Connecting to the 742A Series

CAUTION

Do not apply voltages above the maximum voltage printed on the front panel. Excessive voltage can cause a permanent shift in resistance value or damage.

The specifications for models with CURRENT and SENSE binding posts require four-wire connections to the standard. Use these binding posts as described in Table 2.

For the case to act as a shield, the CHASSIS GROUND binding post must be connected to earth ground or instrument guard at some point in a calibration system. Normally when two or more instruments with guards are connected together, the use of a single common grounding point avoids ground loops. If applicable, ground the 742A CHASSIS GROUND binding post to that common grounding point.

Figure 3 shows a typical connection to a four-wire ohmmeter. Figure 4 shows the connection used to calibrate the 1Ω internal resistance standard in the 5700A.

Cable Recommendations

For optimum results, use two sets of the Fluke 5440A-7004 Low Thermal Test Leads, which are designed to reduce errors caused by thermal emfs.

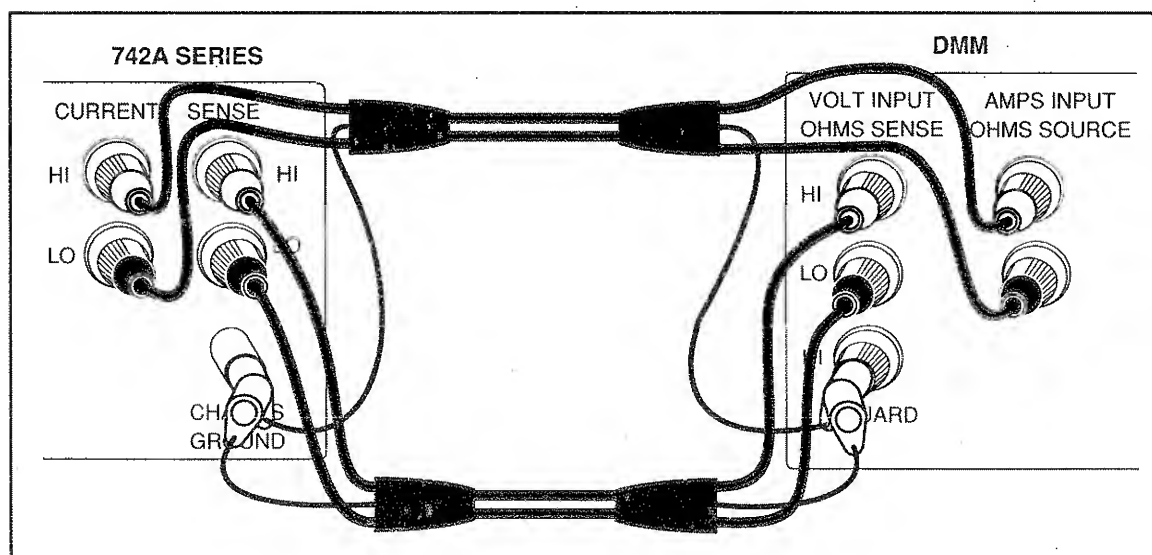


Figure 3. Connection to a Four-Wire Ohmmeter

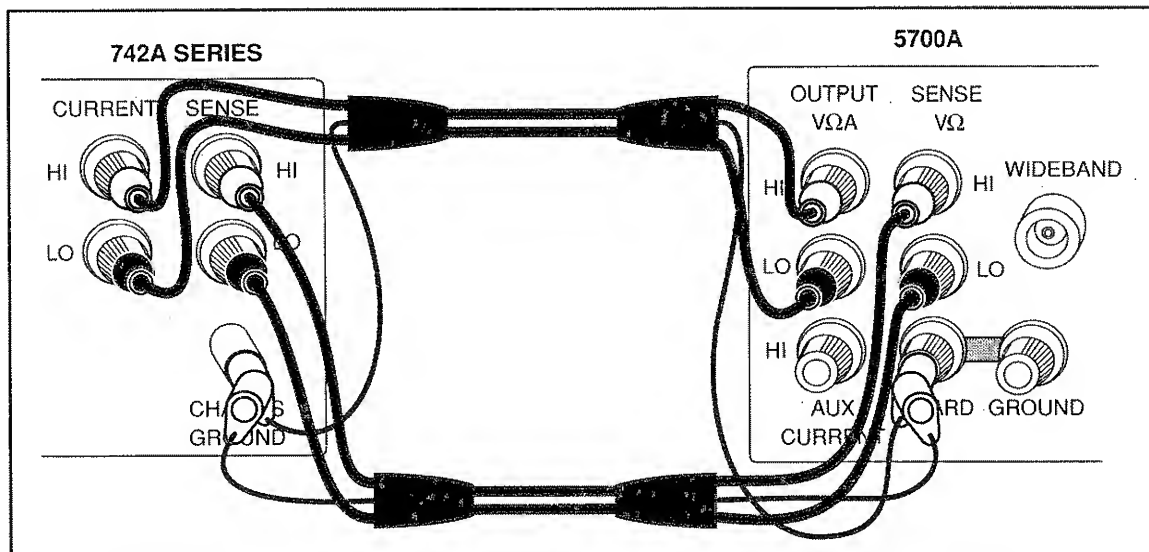


Figure 4. Connection to Calibrate the 5700A

Operating Temperature Range

You can use the 742A Series in ambient temperatures between 18 and 28°C. To predict the deviation from nominal at temperatures other than 23°C, use the temperature characterization table provided with each unit. The table shows the calculated value and the deviation from nominal at temperatures between 18 and 28°C in half-degree increments. An example of this table is included as Table 4.

How Temperature Correction Factors are Calculated

A label on the rear panel shows temperature coefficient factors alpha and beta centered on 23°C. (See Figure 2 for the label location.) The values of alpha and beta are individualized for each 742A. Alpha and beta are established by measurement in the Fluke Primary Standards Lab at 18°C, 23°C, and 28°C. The temperature characterization table is generated from these three measurements and the following formula:

$$R_t = R_{23} [1 + \alpha (t - 23) + \beta (t - 23)^2]$$

Where, R_t = Resistance at $t^\circ\text{C}$
 R_{23} = Resistance at 23°C
 α = Slope of the curve (ppm/°C) at 23°C
 β = Rate of change of slope of the curve (ppm/°C²)

α and β are constants which do not change appreciably over time and hence need to be determined only once.

In the case of the example 742A-1 used in this manual, α and β are calculated as follows:

$$\alpha = \frac{(R_{28} - R_{18})}{\Delta t} = \frac{-0.9 \text{ E-6}}{10} = -0.09 \text{ E-6}$$

$$\beta = \frac{\left(\frac{R_{28} + R_{18}}{2} - R_{23} \right)}{\left(\frac{\Delta t}{2} \right)^2} = \frac{-0.85 \text{ E-6}}{25} = -0.034 \text{ E-6}$$

Where, R_{28} = Resistance at 28°C
 R_{18} = Resistance at 18°C
 R_{23} = Resistance at 23°C
 $\Delta t = (28 - 18) = 10$

Table 4. Example 742A-1 Temperature Characterization Chart

Test Number: XXXX
Date: 04-Aug-88
Page 2 of 2

Serial No.: XXXXXX
Alpha = -0.090 E-6
Beta = -0.034 E-6

| Temp (Celsius) | Resistance (OHMS) | Dev from nominal (in ppm) |
|-------------------|------------------------|------------------------------|
| 18.0 | 1.0000006 | 0.6 |
| 18.5 | 1.0000007 | 0.7 |
| 19.0 | 1.0000008 | 0.8 |
| 19.5 | 1.0000009 | 0.9 |
| 20.0 | 1.0000010 | 1.0 |
| 20.5 | 1.0000010 | 1.0 |
| 21.0 | 1.0000010 | 1.0 |
| 21.5 | 1.0000011 | 1.1 |
| 22.0 | 1.0000011 | 1.1 |
| 22.5 | 1.0000010 | 1.0 |
| 23.0 | 1.0000010 | 1.0 |
| 23.5 | 1.0000009 | 0.9 |
| 24.0 | 1.0000009 | 0.9 |
| 24.5 | 1.0000008 | 0.8 |
| 25.0 | 1.0000007 | 0.7 |
| 25.5 | 1.0000006 | 0.6 |
| 26.0 | 1.0000004 | 0.4 |
| 26.5 | 1.0000003 | 0.3 |
| 27.0 | 1.0000001 | 0.1 |
| 27.5 | 0.9999999 | -0.1 |
| 28.0 | 0.9999997 | -0.3 |

Figure 5 shows a graph of the value of the 742A-1 represented by the sample temperature characterization chart (Table 4). To illustrate use of the formula, calculations for resistance at 20°C and 26°C are shown. You can see that using the formula shown with alpha and beta you get the same value as in the characterization table.

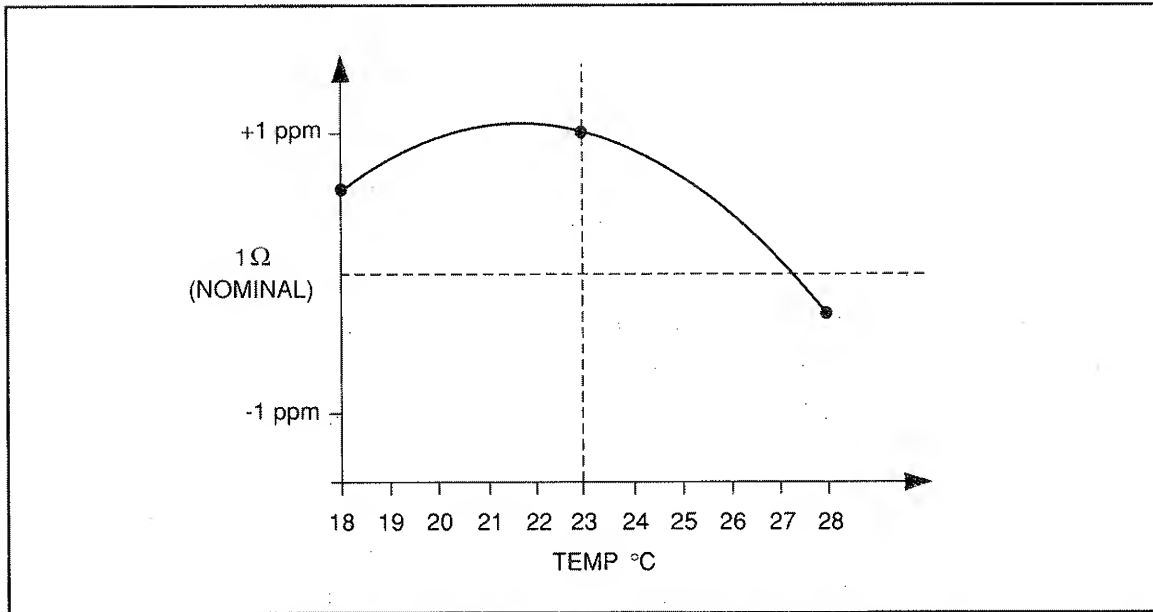


Figure 5. Graph of Resistance VS. Temperature for Sample 742A-1

$$\begin{aligned}
 R_t &= R_{23} [1 + \alpha (t - 23) + \beta (t - 23)^2] \\
 \text{At } &= 20^\circ\text{C}, \\
 R_{20} &= 1.0000010 [1 + (-0.09 \text{ E-}6) (-3) + (-0.034 \text{ E-}6) (-3)^2] \\
 &= 1.0000010 (1.0000003 - 0.0000003) \\
 &= 1.0000010 (1.0000000) \\
 &= 1.0000010\Omega
 \end{aligned}$$

$$\begin{aligned}
 R_t &= R_{23} [1 + \alpha (t - 23) + \beta (t - 23)^2] \\
 \text{At } &= 26^\circ\text{C}, \\
 R_{26} &= 1.0000010 [1 + (-0.09 \text{ E-}6) (3) + (-0.034 \text{ E-}6) (3)^2] \\
 &= 1.0000010 (1 - 0.0000003 - 0.0000003) \\
 &= 1.0000010 (1 - 0.0000006) \\
 &= 1.0000004\Omega
 \end{aligned}$$

Storage Temperature Range

To maintain accuracy within the specified limits, do not subject the 742A Series to temperatures below 0°C or above 40°C. If exposure to temperatures outside this range is unavoidable, you can minimize the adverse effects by doing the following:

- Keep the standards in the optional transit case (Option 742A-7002). The transit case is insulated and helps protect the standards during short-term temperature extremes.
- Keep exposure to temperature extremes brief.

CARE AND MAINTENANCE

The only maintenance procedure for the 742A Series is occasional cleaning. The following text gives cleaning instructions and precautions for handling.

Cleaning the 742A Series

To keep the 742A Series looking like new, clean the outer surfaces using a soft cloth slightly dampened with water or a non-abrasive mild cleaning solution that does not harm plastics.

CAUTION

Do not use aromatic hydrocarbons or chlorinated solvents for cleaning. They can damage the plastic materials used in the resistance standard.

Precautions for Handling

The 742A Series are designed for mechanical stability, but do not abuse the standard with excessive shock. Avoid temperature extremes as mentioned under "Storage Temperature Range". When you transport the standard, it is recommended that you use the Option 742A-7002 Transit Case for shock and temperature protection. The case holds two 742A Series Resistance Standards.

SERVICING INFORMATION

Because the 742A Series are certified and non-adjustable resistance standards, they are considered non-user repairable. If the unit is damaged, it must be returned to the factory for repair and recalibration.

RECERTIFICATION

For recertification, send the resistance standard to a Fluke technical center. For a nominal fee, Fluke will remeasure and recertify the value of your 742A based on comparison to standards traceable to the U.S. National Bureau of Standards. A new temperature characterization chart is provided on recertification. If you wish, you can record the changes at each recertification and use this data to more closely predict the performance of your 742A. A list of sales and service centers is located near the end of this manual.

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(602) 438-8314

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(602) 790-9881

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Burbank, CA 91504
(213) 849-7181

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(408) 727-0513

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16969 Von Karman
Suite 100
Irvine, CA 92714
(714) 863-9031

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Aurora, CO 80014
(303) 695-1000

Connecticut

Hartford

Glen Lochen East
41-C New London Turnpike
Glastonbury, CT 06033
(203) 659-3541

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Miami

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Orlando, FL 32803
(305) 896-4881

Tampa

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Georgia

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Suite 150
Marietta, GA 30067
(404) 953-4747

Illinois

Chicago

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Palatine, IL 60067
(312) 705-0500

Indiana

Indianapolis

8777 Purdue Road
Suite 101
Indianapolis, IN 46268
(317) 875-7870

Louisiana

New Orleans

(504) 455-0814

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Boston

Middlesex Technology Center
900 Middlesex Turnpike
Building 8
Billerica, MA 01821
(617) 663-2400

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5640 Fishers Lane
Rockville, MD 20852
(301) 770-1570

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(313) 522-9140

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Bloomington, MN 55420
(612) 854-5526

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Suite 160
St. Louis, MO 63146
(314) 993-3805

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Greensboro, NC 27408
(919) 273-1918

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Paramus

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Paramus, NJ 07653-0930
West 75 Century Road
Paramus, NJ 07652
(201) 262-9550

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Rochester, NY 14622
(716) 323-1400

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7271 Engle Road
Middleburg Heights, OH 44130
(216) 234-4540

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Northeast

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Oregon

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(215) 647-9550

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San Antonio, TX 78216
(512) 340-0498

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Washington, DC

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TLX: (790) AA25887
FAX: (61) 2-733663

Elmeasco Instruments Pty, Ltd.

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12 Maroondah Highway
Ringwood, Victoria 3134
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TLX: (790) AA30418
FAX: (61) 3-879-4310

Elmeasco Instruments Pty, Ltd.

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Salisbury, Qld Australia 4107
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TLX: (790) AA44062

Elmeasco Instruments Pty, Ltd.

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Prospect, South Australia 5082
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Elmeasco Instruments Pty, Ltd.

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32 Teddington Rd.
Victoria Park
Western Australia 6100
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Philips Scientific & Industrial

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North Ryde
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Tel: 88 88 222

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**Walter Rekirsch Elektronische
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(For Fluke products)
Vertrieb KG
Obachgasse 28
1220 Vienna, Austria
Tel: (43) (222) 253626
TLX: (847) 134759
FAX: (43) (222) 257275

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Tel: (0222) 60101/1772 DW

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